

**THE PARASITOID *TRIOXYS TENUICAUDUS* STARÝ
(HYMENOPTERA: APHIDIIDAE) ESTABLISHED ON THE
ELM APHID *TINOCALLIS PLATANI* KALTENBACH
(HOMOPTERA: APHIDIDAE) IN
BERKELEY, CALIFORNIA**

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Tinocallis platani Kaltenbach is an arboricolous aphid in the Drepanosiphinae, tribe Phyllaphidini. Members of this tribe have alate fundatrigeniae and viviparae (Eastop, 1977). This species is monophagous on elms (*Ulmus* spp.) and is known widely from Europe and Russia (Mackauer and Starý, 1967). Starý (1966) lists it attacking *Ulmus effusa* Willd. in Czechoslovakia. It has been introduced into western North America and is known there from British Columbia, Utah and California (Richards, 1967). High summer populations of the aphid excrete sizable amounts of honeydew, which causes a nuisance and irritation for people beneath elms planted as shade trees.

In Berkeley, California insecticides were used against this aphid from about 1945 to 1971. Two treatments were applied per season, diazinon being the material reportedly used in recent years. Berkeley maintenance personnel report that these applications had decreasing effectiveness. In 1971, water-washing of the trees to reduce aphid populations was substituted for insecticide use as an interim measure while parasitoid introduction proceeded.

In 1972, R. van den Bosch collected two parasitoid species from elm aphids in the area of Prague and South Moravia, Czechoslovakia. These parasitoids were identified as *Trixys hortorum* Starý and a new species, *Trixys tenuicaudus* Starý (Carver and Starý, 1974; Starý, 1978). Both were released on Los Angeles Street in Berkeley. Contrary to earlier reports (Olkowski et al., 1976), *T. hortorum* has not become established. This paper

documents field observations prior and subsequent to parasitoid releases, showing the establishment and spread of *T. tenuicaudus*.

Materials and Methods

Three areas were sampled in this study. Los Angeles Street with 35 elms was the release site. A half-mile away is Hopkins Street with a group of approximately 50 elms, and located 3 miles across town on Ashby Avenue are 5 elms. By sampling the sites at Hopkins Street and Ashby Avenue, we were able to record the dispersal of the aphid from its point of release.

Aphid population size was assessed by randomly sampling leaves from the canopy of selected trees at each of the study sites and counting the number of aphids on each leaf. For the years 1971, 1975, 1976 and 1979, mean values are presented based on sample sizes of 80, 40, 40 and 80 leaves, respectively, for each sample date. Ladders or mechanized lifts were used to reach tree canopies.

After collection in Czechoslovakia, parasitoids were shipped to the University of California Division of Biological Control quarantine laboratory at Albany, where they were reared on field-collected twigs infested with aphids. F_1 adults were released directly onto field populations in 1972. Aphids from the field were dissected to assess parasitism. Leaves with aphids were collected, placed in plastic bags, and transported to the laboratory for dissection. In 1974 a mean of 39.2 aphids were dissected on each of five dates, with total dissections ranging from 22 to 75. In 1975, 50 aphids were dissected on each of 3 dates. In 1976 a mean of 28.3 aphids were dissected on each of 10 dates, with 3 to 50 dissections per date. Those dates for which sample sizes were from 3 to 11 (or less than 50) are indicated in Fig. 1. In 1975, 25 aphids were sampled and dissected on each of 19 dates.

Results

In May 1971, when aphid monitoring of elms was initiated for the first time in many years, no insecticide treatments had been applied. The untreated aphid populations produced copious honeydew excretions, resulting in numerous citizen complaints to the city about trees. Sidewalks beneath such trees became exceedingly sticky and darkened by honeydew rain. Leaves became sticky to touch. Starting on June 4 and June 14, 1971, more detailed population counts were made on four trees with particularly heavy aphid populations along Los Angeles Street. An average for the combined samples for June 4 was 14.8 aphids/leaf and for June 14 was 42.1 aphids/leaf, with 100% of the leaves infested on both dates. These pre-importation numbers, shown in the box on Fig. 1, serve as a rough scale of comparison to population levels after the parasitoid introductions which occurred the following year. The vertical axes in the graphs of mean number of aphids per

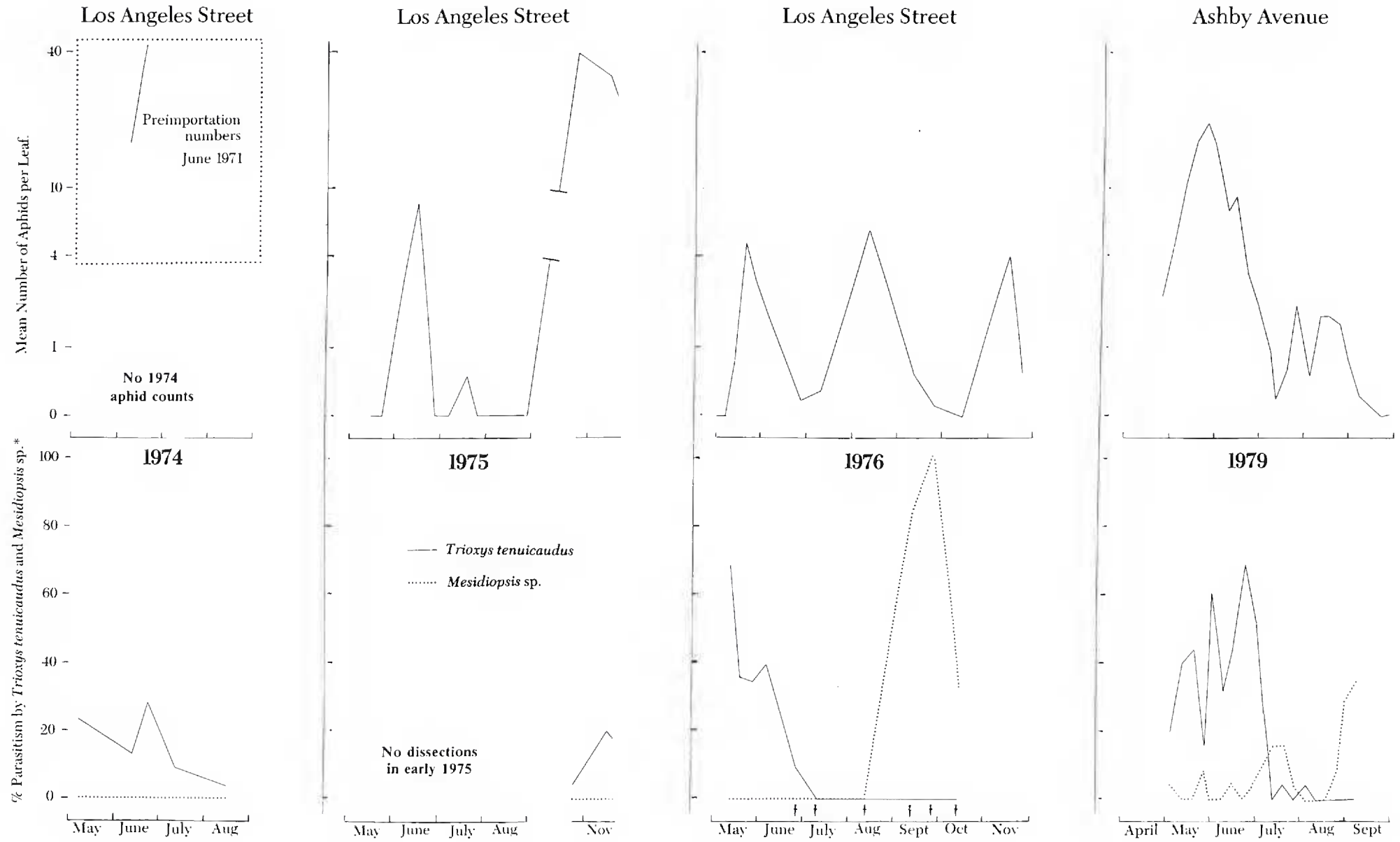


Fig. 1. Population density of the Elm Aphid *Tinocallis platani* and degree of parasitism by *Trioxys tenuicaudus* and *Mesidiopsis* sp. in Berkeley, California. * Sample sizes from 22 to 75 except those 1976 samples indicated by † where sample sizes were from 3 to 11.

leaf (Fig. 1) are log scales. The points in the graphs were determined by calculating $\log(N + 1)$, where $N = \text{aphids/leaf}$.

In June and July 1972, 60 *T. tenuicaudus* adults were released on elms along Los Angeles Street. In 1973, monitoring was started to determine establishment of the released parasitoids. The only parasitoid detected in these samples was a *Mesidiopsis* sp. (at the time believed to be *M. subflavescens* Westwood, but we regard it as an undescribed species). This aphelinid appears to be common in and probably native to California, where it is present on native oak aphids such as *Tuberculatus* sp. At the end of the 1973 season, a detailed examination of release trees on Los Angeles Street was conducted. No *Trioxys tenuicaudus* parasitized aphids were found; however, *Mesidiopsis* mummies were again common.

The first recoveries of *T. tenuicaudus* occurred in the spring of 1974 at the release site. This was the first indication of a successful colonization. Dissections later that season indicated parasitism as high as 28% (Fig. 1). Aphid populations were low throughout the spring of 1975 except for the week of June 14, when populations reached 6 aphids per leaf. *T. tenuicaudus* parasitism in 1975 (ca. 20%) became evident in the autumn before leaf fall, when aphid numbers were extremely high, between 35 and 40 aphids/leaf. In 1976, *T. tenuicaudus* showed a high of 68% parasitism in the spring, while *Mesidiopsis* sp., based on a few dissections, appeared in the fall. Except for the fall peak in 1975, aphid numbers have remained low on Los Angeles Street since, with no aphid complaints received.

In order to follow the spread of the parasitoid, aphids were sampled and dissected from sites one-half mile and three miles from the release site on Hopkins Street and Ashby Avenue respectively, where no parasitoids had been released. Samples taken in June 1974 after the first recoveries at the release site at Los Angeles Street revealed no parasitism at either Hopkins or Ashby, based on 35 and 15 dissections respectively. In 1977, *T. tenuicaudus* was found for the first time on Hopkins Street, based on emergence of the wasp from collected aphid mummies. In 1978, both *T. tenuicaudus* and *Mesidiopsis* sp. were found on Hopkins Street, and *T. tenuicaudus* appeared for the first time on Ashby Avenue. Thorough sampling on Ashby Avenue in 1979, when the aphid population peaked at 19 aphids/leaf (Fig. 1) again revealed parasitism of both *T. tenuicaudus* and *Mesidiopsis* sp., with the imported parasitoid especially active throughout the first half of the season.

Discussion

Trioxys tenuicaudus, an aphidiid parasitoid of the elm aphid *Tinocallis platani*, was introduced in Berkeley in 1972. This parasitoid was first recovered two years later at the release site. Resident complaints diminished as aphid populations no longer reached numbers causing excessive honey-

dew drip. This constitutes the second instance of classical biological control applied to a shade tree aphid pest.

The aphelinid *Mesidiopsis* sp., also found to parasitize the elm aphid, showed a distribution often occurring separately from the introduced *T. tenuicaudus*. *Mesidiopsis* generally occurred later in the season and overlapped minimally with *T. tenuicaudus*. Further work is required to reveal whether this pattern reflects an ecological preference for a given portion of the season, a direct interaction between the species or a disequilibrium in parasitoid-prey relations.

Spread of aphidiid parasitoids from the initial site of colonization may be related to the stage of host attacked. Presumably, winged adults carry the parasitoids to new locations. *T. tenuicaudus* prefers to attack early instars, particularly I and II; we rarely found it in adult hosts. It spread very slowly, taking six years to move a few blocks from the site of initial colonization. In contrast, another aphidiid, *T. curvicaudus* Mackauer, which parasitizes the linden aphid, *Eucallipterus tiliae* (Linnaeus), oviposits in adults and later instars (Olkowski, in prep.). This parasitoid spread three miles across Berkeley in a single season.

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Footnote

¹ Deceased.